1 270 984

PATENT SPECIFICATION

(11) 1 270 984

DRAWINGS ATTACHED

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(54) METHOD AND APPARATUS FOR SPRAY COATING MAGNETIC MEMORY DISCS

(71) We, MEMOREX CORPORATION, of 1180, Shulman Avenue, Santa Clara, State of California, 95052, United States of America; a Corporation organised and existing under the laws of the State of California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

As is well known in the art, memory discs consist of thin annular members having an oxide coating on the face thereof capable of retaining magnetic signals. Information is recorded on the magnetic faces by a recording head which puts the message into the memory. The message may later be recovered as desired.

In British Patent Specification 1,153,368 a device is disclosed for spraying a magnetic coating on discs. In that device, a more uniform thickness of the coating is obtained than in prior work by spraying the coating from an oscilating head along a multitude of paths from the outside diameter of the disc to the inside diameter. While that device has certain advantages, we have found that it produces discs having substantial signal modulation because of non-uniformity in coating thickness. Thus, according to the preferred embodiment described in Patent Specification 1,153,368 the oscillating spray head makes sixteen passes from the outside diameter to the inside diameter of the disc. It has been determined that each pass results in a peak and a trough, with the peaks having a thickness as much as fifty percent or more greater than the thickness at the troughs. This variation gives rise to a sixteen cycle modulation in reading the disc along a circular path. It is desirable to reduce this modulation to less than fifteen percent.

This invention relates to a method and apparatus for applying a magnetic coating to a memory disc by rotating the disc at a constant rate about its axis, masking an inner annular portion of the disc, directing a stream of coating material to the disc and advancing the stream of coating material radially inward across the surface of the disc at a velocity inversely proportional to the distance between the spray stream and the axis of rotation of the disc.

It is an object of this invention to provide an improved method of applying coating of uniform thickness to memory discs to eliminate signal modulation.

It is a further object of this invention to provide an improved method of coating a disc so that there is only one peak and one trough in the thickness of the coating in any given concentric circular path on the face of the recording disc over which a recording head would fly during operation of the coated disc. In this manner, unwanted signal modulation is substantially reduced.

It is another object of the invention to provide such a coating method and apparatus in which the coating is applied in a spiral pattern which has a large number of turns and where the coating is applied in a large area spray so that each point on the disc receives spray during many turns of the spiral. In this way, thickness variation between the peaks and valleys of the spiral may be reduced.

It is a further object of this invention to provide a simple spray means having a limited number of moving parts which makes only a single path over the face of a memory disc to give a uniform coating.

Description of the Drawing

Fig. 1 is an isometric view of an apparatus for coating memory discs with sections broken away to show portions of the interior of the apparatus;

Fig. 2 is a side elevational view of the spray gun mounting and its associated positioning means;

Fig. 3 is a top plan view of the mounting means used to position the spray gun in section along lines 3-3 of Fig. 2;

Fig. 4 is an end elevation view along lines 4-4 of Fig. 2;

Fig. 5 is a side elevational view of an

alternative positioning means for the spray gun;

Fig. 5A is a sectional view taken along the plane indicated at 5A-5A in Fig. 5;

Fig. 6 is a diagrammatic plan view of the disc showing an exaggerated path of coating material and the circular path of the reading head;

Fig. 7 is a graph showing the plot of position of gun means with respect to the disc versus time where the plot has the shape of the equation $y=Y_0-KT^2$.

Description of Preferred Embodiments

Referring to Fig. 1 of the drawing, the coating apparatus 11 comprises a housing 12 having a door 13 in the top thereof to permit access to the interior of the housing. Within housing 12 is a chamber 14 which is supported within the housing 12 by any suitable structural member. The coating chamber 14 is supplied with purging air from an external source (not shown) through duct 15. The purging air is filtered through a large air filter 16 before it passes into coating chamber 14. The purging air then exhausts through duct 17.

Within the coating chamber 14 is a spindle 21 for mounting a disc 22 for rotation. A mask 23 covers the opening in the annular disc 22. As shown in the drawing, spindle 21 is vertically oriented and disc 22 rotates in a horizontal plane about its central axis. Spindle 21 is mounted in any suitable fashion in housing 12. In order to drive spindle 21 at a constant rotation rate, it is preferred to use a pulley arrangement as shown in Fig. 1. Pulley 24 is secured to the lower end of the shaft spindle 21 and is driven by an electric motor 26. Motor 26 drives shaft 27 which, in turn, drives shaft 28 through gear 29. At the end of shaft 28 is pulley 31 which is interconnected with pulley 24 by belt 32, thereby driving spindle 21 bearing disc 22. The disc is mounted on spindle 21 in any suitable fashion, such as that shown in British Patent Specification 1,153,368.

Mask 23 is adapted to be removed from disc 22 to permit removal of the disc. Mask 23 is mounted on arm 36 which pivots on an axis (not shown) to permit movement of mask 23 to the position indicated in dotted lines in Fig. 1.

The coating material may be any suitable sprayable composition having the appropriate magnetic properties. By way of example, iron oxide or chromium dioxide, dispersed in an epoxy binder, have been found satisfactory for spraying onto the face 33 of disc 22.

The coating material is sprayed through a gun 37. The coating material enters the gun from an external source (not shown) through tube 38. In the preferred embodiment, gun 37 is mounted in such a manner as to direct a perpendicular stream to the face of disc 22.

Positioning of the gun is accomplished by moving gun 37 radially inward across the face of the rotating disc. The means for positioning is best shown in Figs. 2 and 3. Gun 37 is mounted vertically above the disc 22 by means of a U-shaped bracket 39. Gun 37 is attached to bracket 39 by mounting the gun on shaft 41 which is adjustably retained in the bracket 39. The bracket 39 is affixed to a rail 42 which, in turn, is affixed to shafts 43 and 44. Rail 42 is attached to shafts 43 and 44 by means of screws 46 and 47, which tap into shafts 43 and 44, respectively.

The shafts 43 and 44 are slidably retained in clamp 48. Shaft 43 engages a bushing 49 retained in clamp 48 by a set screw 52. Similarly, shaft 44 engages bushing surface 51 which is retained in clamp 48 by set screw 53.

Referring to Fig. 2, the positioning of gun 37, which is attached to shafts 43 in the manner just described, is accomplished by sliding shafts 43 and 44 within the bushings of inward clamp 48 and outward clamp 54. Clamp 54, like inward clamp 48, slidably engages shafts 43 and 44. Shaft 43 engages bushing 56 which is retained in claim 54 by set screw 57. Shaft 44 engages bushing 58 which is retained in clamp 54 by means of set screw 59.

Clamps 48 and 54 are fixedly mounted on base plate 61, as best seen in Fig. 2. Base plate 61 is, in turn, attached to housing 12 by means of booth cross straps 62 and 63.

Clamp 54 is located outwardly, with respect to the disc and serves to retain shafts 43 and 44 parallel along with the clamp 48.

At the outward end of shafts 43 and 44 there is mounted a second rail 64. This rail, like rail 42, is attached to shafts 43 and 44 by screws 66 and 67, respectively. A cam follower 68 is mounted on rail 64 by an appropriate means, such as bolt 69. Cam follower 68 moves according to the contours of cam 71 which is retained on shaft 72 driven by motor 73.

In operation, motor 73 drives shaft 72 which rotates cam 71. Cam follower 68 affixed to rail 64, slides shafts 43 and 44 within clamps 48 and 54 so that gun 37, mounted on forward rail 42 moves inwardly or outwardly, according to the contours of cam 71.

In order to keep cam follower 68 against cam 71, appropriate tension means 76 are provided. In the embodiment shown in Fig. 2, tension means 76 comprises a bracket 77 affixed to base plate 61 and engaging a coil spring 78. The end of coil spring 78 is secured to rail 42 by means of a flat-head screw 79. Thus, the gun 37 and its associated support means affixed to shafts 43 and 44 are constantly tensioned to the left in Fig. 2 with

the result that cam follower 68 follows all of the contours of cam 71.

An alternative embodiment to the positioning means shown in Figs. 2 through 4 is illustrated in Fig. 5. In this embodiment, a variable pitch lead screw is substituted for the cam as the control of the speed of the spray gun along a radius of the disc to be coated. Thus, referring to Fig. 5, motor 81, through a speed control means 82 drives shaft 83 upon which is a pulley 84. Pulley 84, in turn, drives pulley 87 by means of belt 86. Pulley 87 is on a common shaft 88 with a variable pitch lead screw 89. Because of the constant drive speed of pulley 86 from motor 81, screw 89 rotates at a constant rate. However, the pitch of the screw surfaces placed upon variable pitch lead screw 89 is such that the threads of the screw are more closely spaced at the inward end which is to the right in Fig. 5. Screw 89 is followed by camrol 91 which is affixed to a slide plate 92 which rides on two shafts, one of which is shown as 93 in Fig. 5. As camrol 91 and slide plate 92 proceed to the right in Fig. 5 following the thread of screw 89, the speed of the movement increases. Since gun 37 is suspended from slide plate 92 by weldment 94, it is apparent that gun 37 moves more rapidly to the right (inwardly) as camrol 91 follows lead screw 89 to the right.

Slide plate 92 may conveniently include bushing surfaces which enclose each of the shafts in two places in a manner similar to clamps 53 and 54 shown in Figs. 3 and 4. When slide plate 92 with its associated camrol 91 have proceeded along lead screws 89 to the position shown in dotted lines in Fig. 5, the rate of progress of slide plate 92, bearing gun 37, will have increased, with the result that a lesser quantity of coating material is sprayed upon disc 22 at the inside diameter thereof than at the outside diameter thereof for each revolution of the disc.

Fig. 6 shows an illustration of the pattern on the disc in greatly exaggerated form. It will be noted that the pattern of coating material follows a spiral pattern with the distance between adjacent spirals being greater as the inside diameter of the disc is approached. Fig. 6 is an exaggeration, since in the preferred embodiment more than 100 rotations of the disc take place whereas only a few are shown in Fig. 6. As a matter of fact, the disc preferably rotates at least fifty times while the spray head moves from the outside diameter to the inside diameter of the disc with the spray pattern from the spray gun sufficiently wide that any given point on the disc receives spray from the gun on at least ten consecutive revolutions of the disc.

Circle 96 in Fig. 6 shows the path of a reading head to recover information recorded on the memory of the magnetic disc. Since the reading head follows a circular path 96, it will be apparent that it crosses the center of the spray gun path only once so that only a single peak and a single trough of coating thickness are included in path 96 at points 97 and 98, respectively. In this manner, the thickness variation present with a large number of peaks and troughs, as in the prior art, are avoided.

The curvature of the cam (Fig. 4) or the pitch of the lead screw (Fig. 5) is designed to provide a path of the type shown in Fig. 6. Fig. 7 shows a graph plotting the location of the spray gun, i.e. the position of the cam follower or camrol, depending upon which embodiment is used. The x axis shows uniform time intervals which is the same as angular rotation around the circumference of the cam or variable pitch lead screw from the starting position where the cam or screw rotates at uniform speed. The y axis is the distance of the spray gun at any time from the center of the disc. It will be apparent from the slope of the curve in Fig. 7 that the gun accelerates as the inner diameter of the disc is approached.

The method of the present invention provides a uniform coating of magnetic material by rotating the disc at a substantially constant rate about its axis directing a stream of coating material to the disc. Meanwhile, the stream is advanced radially inward across the surface of the disc preferably at a speed inversely proportional to the distance between the points of impingement of the spray stream and the axis of rotation of the disc to apply a coating which does not change in thickness along the radius of the disc. This relation is obtained by proper selection of the cam shape or variable pitch of the lead screw. This results in a spiral pattern on the disc face as illustrated in Fig. 6. The radial speed of the disc and spray head with respect to each other should be sufficiently low that the maximum pitch of the spiral spray pattern is less than one-half and preferably less than one-tenth of the width of the spray pattern. It has been found that highly satisfactory results occur when the disc is rotated at about 200 rpm, while the spray head is fed from the outside diameter to the inside diameter of the disc over a period of one-half a minute with a spray stream which is applied to the disc having a width of about one-half of the distance between the inside and outside diameters. This gives a very uniform coating where each point on the disc receives spray from the spray head on about fifty turns of the spiral path of the spray head. The disc should not be rotated at such a high speed that the coating on the disc flows radially, as occurs in spin coating, because disc imperfections will cause radial flow lines which produces serious imperfections in the magnetic response of the disc. The maximum speed is determined by coating viscosity and thickness. The minimum rotary speed

is determined by the minimum quantity of material which can be deposited from the gun in any time interval and the width of the spray pattern. It has further been found to be highly satisfactory to position the gun perpendicularly to the disc so that the spray stream impinges upon the face of the disc at right angles. Of course, where desired, other angular orientation between the gun and the disc may be used particularly where the shape of the gun orifice is controlled.

In normal use of the disc, the recording head places information on a memory disc at any one of 200 circular paths. By maintaining the spiral spray pattern in a nearly circular path in accordance with this invention, the modulation caused by a multitude of peaks and troughs is minimized. Where the disc rotates at 200 rpm, it has been found expedient to spray upon the disc face for thirty seconds with the result that there are 100 spirals from the outside diameter to the inside diameter of the disc.

In order to avoid the non-uniform coating which results from start up and shut down of the spray gun (spatter), it is preferred to commence operation of the gun at a point outside the outer diameter of the disc. In this manner, any spatter avoids the surface of the disc so there is no build up at points where spatter impinges upon the disc surface.

Similarly, at the inside diameter of the disc, a mask is placed above the disc surface and the gun is shut down when it is over the mask. Any terminal dripping or spatter from the gun is accordingly directed to the mask.

As is common in the art, purging air is directed through the coating chamber in order to remove any undesirable particles and overspray. To keep the air flow from disturbing the spray pattern, it is preferred to use a flow of about 100 feet per minute. However, the rate of flow of clean air may vary within wide limits and forms no part of the present invention.

By following the method of the present invention, modulation in reading the memory has been reduced to an acceptable level. It has been found that no more than fifteen percent variation in thickness between the peaks and troughs should be present, or else noticeable modulation occurs. The practice of the present invention produces a disc coating of such uniform thickness that there is no unacceptable modulation.

It will be apparent from the above description that it is preferable to rotate the disc at constant speed around a vertical axis while moving the spray gun inwardly from the outside diameter of the disc. However, the disc may be rotated about a horizontal axis, particularly where both sides of the disc are sprayed simultaneously. Additionally, the spray head may be moved from the inside diameter to the outside diameter of the disc, and the disc may be moved instead of moving the spray head.

It should be noted that method and apparatus may be used for applying magnetic coatings which vary in thickness in any desired predetermined manner along the radius of the disc as for instance where it may be desirable to provide a coating which is thicker at the outside diameter like the coating produced by spin coating.

Finally, there are certain situations where it may be desirable to change the rotary speed of the disc as the spray head moves over the disc. For instance, the rotary speed of the disc may be increased as the spray head approaches the inside diameter of the disc so that the distance between turns of the spiral spray pattern is constant. The relative radial velocity of the spray head and disc will still be increased as the spray gun approaches the center of the disc, however, so that the gun deposits substantially the same quantity of coating per square inch of disc surface at the inside and outside diameters of the disc.

It will therefore be apparent that the present invention provides a method and apparatus for applying a magnetic coating of uniform thickness upon a disc face to eliminate undesirable modulation.

WHAT WE CLAIM IS:—

1. In a method of applying a magnetic coating to a memory disc, the steps of:

Rotating the disc about its axis;

Obscuring an inner annular portion of said disc;

Spraying a stream of coating material toward the upper surface of the disc;

Continuously advancing the stream of coating material in a single pass in a direction which has a radial component across the disc between a point outside the outside diameter thereof and a point inside the obscured portion thereof while the disc rotates through at least fifty revolutions whereby said coating material is applied in a spiral pattern which crosses any given circular path concentric with the centre of the said disc only once.

2. Apparatus for applying a magnetic coating to a memory disc between the periphery of said disc and a predetermined inward diameter thereof which comprises:

A spindle for supporting a disc and rotating the disc about a generally vertical axis;

A memory disc removably mounted on said spindle coaxial therewith;

A mask smaller than the outer diameter of said disc and mounted above and coaxial of said spindle overlaying a portion of said disc;

A spray gun for spraying a magnetic coating toward said disc;

Supply means connected to said spray gun

for delivering a magnetic coating material thereto;

Support and guidance means supporting said spray gun above said disc and guiding said spray gun along a path between a position outside the periphery of the disc and a position above said mask;

And drive means connected to said spray gun for driving said gun along said path in a single pass while said gun is operating, said drive means having speed control means for driving said spray gun at a velocity which has a component extending radially of said disc and continuously changing in magnitude between a higher radial velocity near the centre of said disc and a lower radial velocity near the periphery of said disc.

3. A method of applying a magnetic coating to a memory disc substantially as hereinbefore described with reference to the accompanying drawings.

4. Apparatus for applying a magnetic coating to a memory disc constructed substantially as hereinbefore described with reference to, and as shown in the accompanying drawings.

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1270984 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

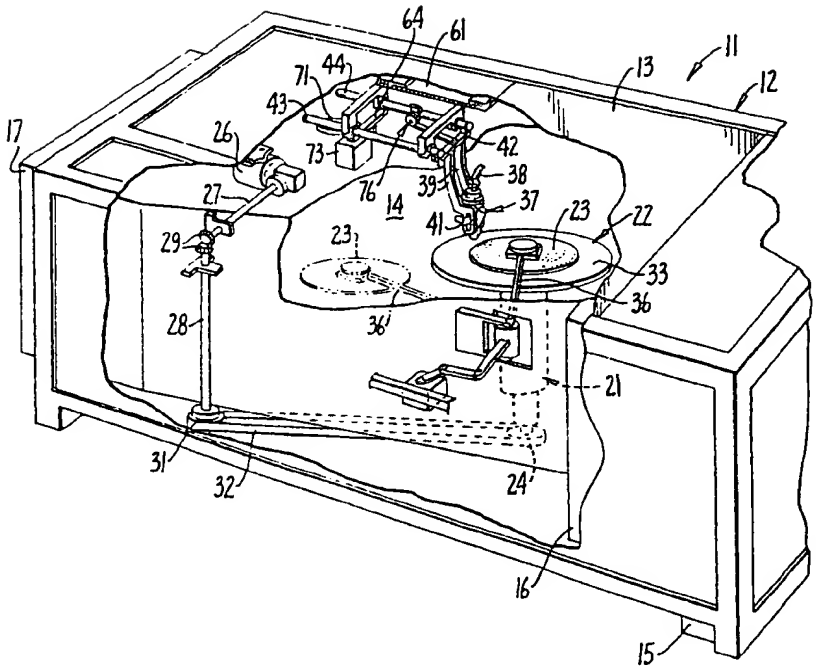

FIG. 1.

1270984 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

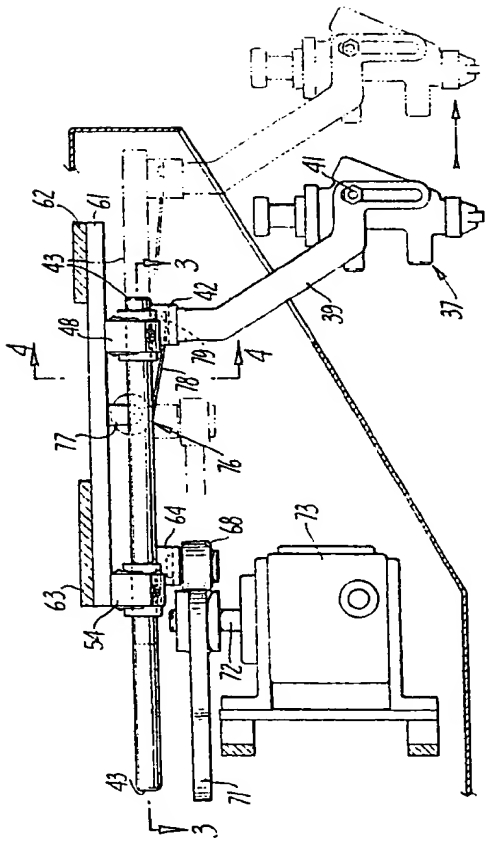

FIG. 2.

1270984 COMPLETE SPECIFICATION
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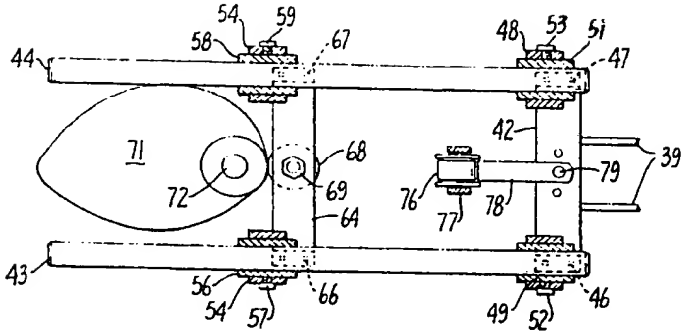

FIG. 3.

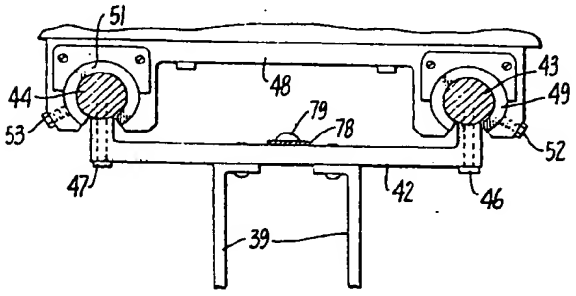

FIG. 4.

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Sheet 4

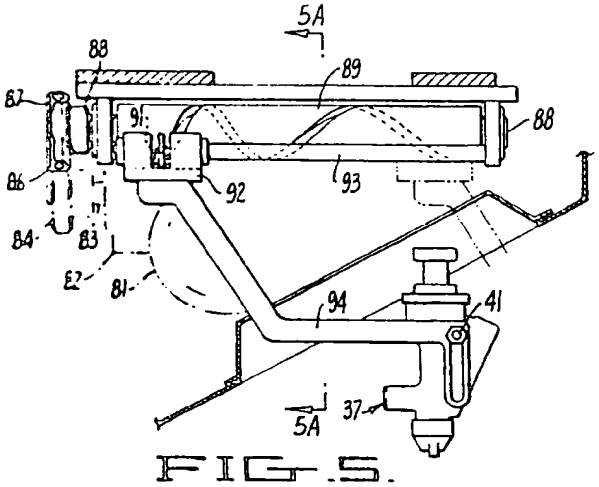

FIG.5.

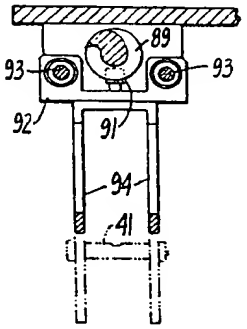

FIG.5A.

1270984 COMPLETE SPECIFICATION
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Sheet 5

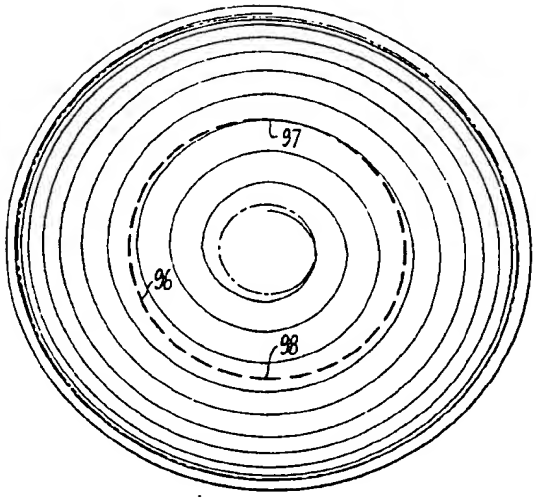

FIG. 6.

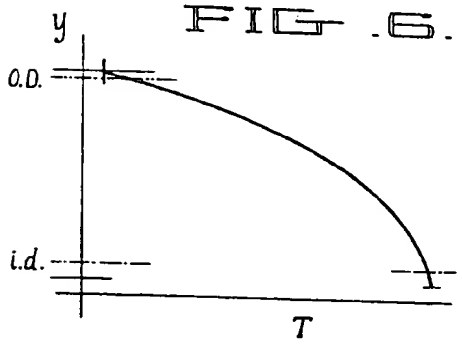

FIG. 7.